Engineering Standard

SAES-A-207 30 November 2004
Catalyst and Desiccant
Selection and Replacement

Document Responsibility: Process & Control Systems Dept.

Saudi Aramco DeskTop Standards

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1 Scope

This standard establishes requirements for selection, quality assurance, quality control, first-fill purchase, and disposal of Catalyst and Desiccant Material Service Group 148000. The Catalyst and Desiccant Material Service Group 148000 consists of desiccant, Claus catalyst, and refining process catalysts. The purpose of this standard is to implement a program that results in the cost-effective management of catalyst.

2 Conflicts and Deviations

2.1 Any conflicts between this standard and other applicable Saudi Aramco Engineering Standards (SAESs), Materials System Specifications (SAMSSs), Standard Drawing (SASDs), or industry standards, codes, and forms shall be resolved in writing by the Company or Buyer's Representative through the Manager, P&CSD of Saudi Aramco, Dhahran.

2.2 Direct all requests to deviate from this standard in writing to the Company or Buyer's Representative, who shall follow internal company procedure SAEP-302 and forward such requests to the Manager, P&CSD of Saudi Aramco.

3 References

The procedures and testing covered by this standard shall comply with the latest edition of the references listed below, unless otherwise noted.

3.1 Saudi Aramco References

Saudi Aramco Engineering Procedure

SAEP-302	*Instructions for Obtaining a Waiver of a Mandatory Saudi Aramco Engineering Requirement*

Saudi Aramco Forms

Form 1149	*Materials Cataloging (New Material)*
CU 05.1	*Claims Against Vendor*
Form 8920	*Direct Charge Purchase Requisition*

Materials Instruction Manual

CU 11.1	*Cataloging*

3.2 Industry Codes and Standards

American Society for Testing and Materials

ASTM D-0.05 Committee Proceedings

4 Definition and Acronyms

Catalyst and Desiccant Material Service Group 148000: In this standard, Catalyst and Desiccant has been categorized into desiccant, Claus catalyst, and refining process catalysts. Desiccant includes molecular sieve, activated alumina, and silica gel.

Commercial Batch Sample: A composite sample of each Catalyst and Desiccant Material Service Group148000 currently in use by Saudi Aramco to be uniformly taken during the loading of each batch of catalyst into the reactor or catalyst storage hopper at the facility. The minimum homogeneous sample quantity retained is 18 kilograms for desiccant, and three kilograms for Claus catalyst and each main refining process catalyst.

Major Operating Mode: The major operating mode is defined as one that has been documented as occurring 10% or more of the time over the latest full cycle.

Minor Operating Mode: The minor operating mode is defined as one that has been documented as occurring less than 10% of the time over the latest full cycle.

Organization Representative: The organization representative serves as the source of information at each facility or department regarding execution of SAES-A-207 and ensures that the standard is followed.

Pilot Plant (P/P) Testing: The process of testing the performance of catalysts at conditions simulating the actual plant operations. These tests are performed at R&DC or at outside testing laboratories.

Pilot Plant (P/P) Testing Samples: A number of catalyst samples requested for pilot plant testing and QA/QC testing in order to validate vendor performance claims.

Plant Trial: The testing of a desiccant, Claus catalyst, or refining process catalyst in a plant, to establish its performance and suitability for the service.

Pre-delivery Samples: These representative samples are obtained from every shipment for QA/QC testing. Pre-delivery Samples are required for all Catalyst and Desiccant Material Service Group148000; and they should meet vendor's product specification through R&DC tests before being shipped to the facility. The minimum sample size is five kilograms for desiccant and one kilogram for refining process catalysts and Claus catalyst.

Pre-development Requisition: A purchase requisition initiated by Operations Engineering Unit (OEU) to start the catalyst procurement process. This Pre-

development Requisition should contain delivery information, required catalyst quantity and estimated catalyst price.

Proforma Performance Guarantee: A legal document developed by Saudi Aramco for performance guarantee of Catalyst and Desiccant Material Service Group 148000 by vendors. The Proforma Performance Guarantee is developed by OEU with assistance from RTSD, P&CSD and Law Department. Vendors are requested to fill in performance guarantee values, such as cycle life, total life, product yields and qualities, conversion, hydrogen consumption, etc., in this document and submit it together with their proposals to Purchasing. Proforma Performance Guarantee should include feed and product information, and operating conditions for the specific unit.

Quality Assurance/Quality Control (QA/QC): In the context of this standard, QA generally includes R&DC, P&CSD, and Standardization, as well as matters relating to selection, screening, performance testing, and plant trials of catalyst. QC is addressed primarily by the vendor with the appropriate tests and values defined by R&DC and P&CSD and included in any related purchase order or agreement.

QA/QC Testing: The testing of catalyst to verify suitable physical and chemical properties. All tests will be carried out in accordance with the secrecy agreement signed with the catalyst vendors. QA/QC tests for FCC catalyst typically include, but are not limited to Al_2O_3, Na_2O and Re_2O_3 contents; microactivity; apparent bulk density (ABD); particle size distribution; average particle size; unit cell size; matrix, zeolite and total surface areas; and attrition index. QA/QC tests for Claus catalyst typically include porosity, surface area, crush strength, ABD, particle size distribution, and pore size distribution. QA/QC tests for refining process catalysts, excluding FCC catalysts, typically include metal contents, ABD, crush strength, attrition, surface area, pore volume, and pore size distribution. Tests for desiccant typically include crush strength, accelerated degradation, rate of water vapor uptake, and mass transfer zone characteristics.

Qualification Testing: This testing is performed in accordance with Section 6.1 to determine if a candidate desiccant and Claus catalyst can be used for a process application more effectively than the current one in service. Qualification testing doesn't apply to refining process catalysts, which require evaluation on an individual basis.

Responsible Standardization Agent (RSA): The Responsible Standardization Agent for Catalyst and Desiccant Material Service Group148000, the responsible agency, with the concurrence of Materials Standardization, to be the technical authority on issues related to Catalyst and Desiccant Material Service Group148000. However, the RSA needs to consult with P&CSD for issues related to desiccant, Claus catalyst, and refining process catalysts. (See Materials Instruction Manual CU 11.1 Cataloging.)

Commentary Note:

The name and telephone number for the RSA can be obtained from Materials Standardization or from the DeskTop Standards – Other Information: "RSA Specialists to be Contacted on Matters of Materials Standardization, Stock Simplification, and Source Development."

Research and Development Center (R&DC): R&DC provides quality assurance and pilot plant testing service to Saudi Aramco organizations. Advanced physical characterization and surface property measurement services are also provided to support quality assurance activities.

Standardization Engineer – Catalyst and Desiccant Material Service Group148000: The Materials Standardization Division engineer responsible for the cataloging of new Catalyst and Desiccant Material Service Group148000 items, and the maintenance of the material catalog.

Technical Package: A technical package prepared by OEU and P&CSD that defines a process application including feedstock qualities, unit operating parameters, product specifications, and catalyst performance requirements.

Technical Team: Technical team advises Purchasing in negotiating performance guarantees with vendors. It consists of representatives from P&CSD, R&DC, OEU, RTSD and Law Department.

Total Life Cycle Cost (TLCC): The total operational cost of utilizing a selected catalyst in a process application. TLCC values are utilized for comparison of alternative vendor catalyst offerings that are proposed to replace a catalyst in an existing system.

5 Responsibilities

5.1 Process and Control Systems Department (P&CSD)

The single-point contact for technical consultation related to the use of all types of catalyst in Saudi Aramco. P&CSD assists OEU in developing technical packages and Proforma Performance Guarantee, participates in conducting economic evaluation with Purchasing, coordinates pilot plant testing, and participates in development of recommendations and specifications to replace existing catalyst systems. P&CSD is responsible for maintenance of Technical Package and Proforma Performance Guarantee in livelink after each catalyst selection.

5.2 Research and Development Center (R&DC)

Supports QA/QC activities, participates in development of recommendations,

and conducts pilot plant testing. They retain commercial batch samples to meet future testing requirements. Gas Processing Unit of R&DC is responsible for QA/QC testing of desiccant, and Claus catalyst; Refining Unit of R&DC is responsible for QA/QC testing all refining process catalysts and conducting pilot plant testing.

5.3 Operations Engineering Units (OEU) of Refineries & Gas Plants

OEU initiates refining catalyst selection process for timely replacement. OEU generates Pre-development Requisition, develops Proforma Performance Guarantee with RTSD, P&CSD and Law Department, develops technical packages with P&CSD, and coordinates with P&CSD and R&DC to develop recommendations for replacement of existing catalyst systems with more cost-effective catalyst systems. OEU is responsible for preparing the final purchase requisition using Form 8920. OEU should ensure that catalyst or desiccant is properly stored in closed bags or drums, and under shelter and above the ground before use.

5.4 Facility Planning Department (FPD)

Before selecting an approved Licensor for a grass roots or a revamp project, FPD or PMT shall contact with P&CSD which will liaise with OEU, RTSD, and R&DC to ensure that suitable, cost-effective catalysts and desiccants are specified and purchased for the project.

5.5 Project Management Team (PMT)

Before selecting an approved Licensor for a grass roots or a revamp project, PMT or FPD shall contact with P&CSD which will liaise with OEU, RTSD, and R&DC, to ensure that suitable, cost-effective catalysts and desiccants are specified and purchased for the project. If licensor offers choices for first-fill catalyst for the project, PMT shall consult with OEU, RTSD, P&CSD, and R&DC for catalyst and desiccants selection. PMT shall be the single point of contact with the contractor and vendor when catalyst is provided under a project.

5.6 Purchasing Department, Catalyst and Desiccant Material Service Group 148000 Buyer

Single point contact with vendors and users for all commercial considerations except for a grass roots or a revamp project. Develops competitive bids and notifies facility OEU personnel of the most cost-effective catalyst system for use. Purchasing must forward technical proposals and Proforma Performance Guarantee to P&CSD and OEU for evaluation after receipt, and work with P&CSD to conduct economic evaluation with inputs from FPD, RTSD and R&DC.

5.7 Refining Technical Support Division (RTSD)

RTSD is involved in refining catalyst selection and evaluation including Proforma Performance Guarantee development, and assists in providing operating data for catalyst evaluation. RTSD coordinates with P&CSD and R&DC and acts on behalf of refineries in the negotiation and acceptance of performance guarantees. RTSD is also involved in performance test runs to validate vendor's Proforma Performance Guarantees and is responsible for precious metal accounting.

5.8 Responsible Standardization Agent (RSA)

The RSA is consulted by the Saudi Aramco personnel including proponents on matters of materials standardization, stock simplification, and source development for Catalyst and Desiccant Material Service Group 148000. Also the RSA is consulted on QA/QC procedures and the cataloging of new Catalyst and Desiccant Material Service Group 148000 items. However, the RSA needs to consult with P&CSD for issues related to desiccant, Claus catalyst, and refining process catalysts. The RSA has all of the responsibilities listed in Materials Instruction Manual CU 11.1 plus those contained in this SAES.

5.9 Law Department

Assists OEU, RTSD and P&CSD in developing Proforma Performance Guarantee; and reviews Proforma Performance Guarantee returned by vendors and secrecy agreement.

6 Desiccant and Claus Catalyst

6.1 Qualification Testing of New Desiccant and Claus Catalyst

This protocol summarizes the procedure to qualify new desiccant, which includes molecular sieve, activated alumina, and silica gel; and Claus catalyst. The outlined procedure is applicable in circumstances where:

- Vendor offers a new technology to Saudi Aramco.
- New vendor offers a new material to Saudi Aramco.

6.1.1 Gas Processing Unit in R&DC conducts QA/QC Testing of samples submitted by vendors.

After the successful QA/QC Testing, either Pilot Plant Testing or Plant Trial can be carried out to qualify desiccant or Claus catalyst. The detailed procedures are summarized in Sections 6.1.2 and Section 6.1.3.

6.1.2 Pilot plant testing

Pilot plant testing to qualify desiccant or Claus catalyst shall be carried out using parameters simulating field conditions, as agreed in writing by P&CSD, OEU, R&DC, and the appropriate testing laboratory.

6.1.3 Plant Trial

6.1.3.1 The vendor shall provide a Pre-delivery Sample to the Gas Processing Unit, R&DC at least two months prior to the plant trial.

6.1.3.2 Composite QA/QC samples shall be obtained for all desiccant and Claus catalyst. Facility OEU will forward composite samples obtained during dryer or reactor loading to the Gas Processing Unit, R&DC.

6.1.3.3 The Gas Processing Unit shall retain all samples of desiccant and Claus catalyst qualified for use by a successful plant trial for five years. The minimum sample quantity retained is three kilograms for Claus catalyst and 18 kilograms for desiccant.

6.1.4 After a successful pilot plant test or plant trial, P&CSD with support from R&DC shall notify Catalyst and Desiccant Material Service Group148000 Standardization Engineer to add this new desiccant or Claus catalyst to the qualified vendors list for future purchase. The qualified vendors list will be maintained by P&CSD with the support of R&DC.

6.2 Desiccant Purchase

Figure 1 summarizes desiccant procurement protocol. This protocol should be followed for all desiccants. Any deviation from this selection process will acquire a waiver from the Manager of P&CSD. We suggest that a minimum of six (6) months be allocated to acquire desiccant.

6.2.1 OEU determines the need for replacement of desiccant.

6.2.2 OEU generates Pre-development Requisition and Proforma Performance Guarantee, and OEU and P&CSD generate Technical Package as a basis for the Vendor Quotation. P&CSD and Law assist OEU in developing Proforma Performance Guarantee.

6.2.3 OEU sends Pre-development Requisition and P&CSD sends Technical Package and performance guarantee to Purchasing who requests

written quotation from vendors including performance data, performance guarantees, pricing, and delivery information.

6.2.4 Technical Team assists Purchasing in negotiating performance guarantees with Vendors of the selected desiccants.

6.2.5 Purchasing forwards the technical bids and overall commercial ranking of desiccants based on vendors' proposals and performance guarantees, to OEU and P&CSD for review.

6.2.6 OEU and P&CSD advise Purchasing of all qualified bids including any performance factors and other technical end use cost factors. Purchasing advises the Manager of Gas Plant of the most cost-effective and technically approved bid and solicits approval concurrence.

6.2.7 Purchasing Dept. issues purchase order to vendor allowing adequate time for delivery of desiccant prior to T&I.

6.2.8 Any mixing of desiccants from different manufactures requires approval from P&CSD.

6.2.9 Gas Processing Unit of R&DC analyzes Pre-delivery Samples and notifies OEU, Purchasing, and P&CSD of the results.

6.2.10 OEU conducts performance tests according to facility management directives including those tests and timing required to validate the vendors' performance guarantee.

6.2.11 OEU will retain operating data from start-up through the end of the performance guarantee period. OEU will share operating data with P&CSD and R&DC. OEU will provide molecular sieve performance data to P&CSD, R&DC and the respective vendors after compiling and graphing the respective data.

6.2.12 Gas Processing Unit of R&DC retains Commercial Batch Sample forwarded by OEU for future tests for five years.

6.3 Claus Catalyst Purchase

The following procurement protocol is to be followed for the purchase of Claus catalyst only. Any deviation from this procurement process will acquire a waiver from the Manager of P&CSD.

6.3.1 Before the expiration of the current agreement, Purchasing will solicit bids for a two-year supply agreement from pre-qualified vendors.

6.3.2 Purchasing is to select the most cost-effective Claus catalyst based on price per unit volume. The price per unit volume is to be determined at the supplier's *maximum* guaranteed density.

6.3.3 OEU of gas plants and refineries must contact Purchasing in advance to advise it of their Claus catalyst needs.

6.3.4 Purchasing shall issue a purchase order to the selected vendor, allowing adequate time for delivery of Claus catalyst prior to T&I.

6.3.5 Mixing of Claus catalysts of the same type (alumina or titanium dioxide) from different manufactures does not require approval from P&CSD. Mixing of alumina and titanium dioxide catalyst must be reviewed by P&CSD.

6.3.6 Gas Processing Unit of R&DC analyzes Pre-delivery Samples and notifies OEU, Purchasing, and P&CSD of the results.

6.3.7 Gas Processing Unit of R&DC retains Commercial Batch Sample forwarded by OEU for future tests for five years.

7 Refining Process Catalysts

Figure 2 summarizes refining process catalyst selection protocol. This protocol should be followed for all refining process catalysts excluding Merox catalysts (which are already pre-qualified and catalogued) and make-up catalyst. Make-up catalyst includes the catalyst needed to replenish the loss in FCC and CCR units and the catalyst needed to sustain the level of reactor after skimming. Minor reformulation for FCC catalyst to optimize unit performance including minor modifications in activity, surface area, catalyst particle size distribution, and rare earth metal level is considered as an FCC make-up catalyst. Make-up catalyst purchase for FCC and CCR units is limited to a maximum of five years.

Make-up catalyst requirements should be included in the Technical Package and vendors are required to quote the price and conditions for a catalyst support purchase agreement valid for the catalyst life. At the time of the original catalyst replacement selection, catalyst vendors, if applicable, will be requested to identify ranges of properties (i.e. activity, surface area, catalyst particle size distribution, and rare earth metal level) within which modifications can be made without requiring a change in catalyst support purchase agreement price. Catalyst vendors will also be required to provide pricing data for property changes that fall outside of the identified ranges. The catalyst support purchase agreement should specify that in case the same make-up catalyst is not available when it is required, vendor is obligated to replace it with a better or equivalent technology at no additional cost. Catalyst vendors, if applicable, are required to provide and quote catalyst additives and chemicals used to reduce

product sulfur, extend catalyst cycle life and decrease reactor pressure drop. Make-up catalyst, additives, and associated chemicals specified in the catalyst support purchase agreement will be requested whenever needed during the catalyst life and can be purchased through the support purchase agreement without further justification. Saudi Aramco is not obligated to purchase make-up catalyst during the catalyst cycle.

Any deviation from this selection process will require a waiver from the Manager of P&CSD. It is suggested that at least fifteen (15) months be allocated to purchase catalyst if pilot plant test is not required and at least twenty-one (21) months if pilot plant test is required.

7.1 OEU determines the need for a catalyst replacement. P&CSD consults with OEU, RTSD and R&DC to identify the potential vendors based on experience, knowledge and published information.

7.2 OEU generates Pre-development Requisition and Proforma Performance Guarantee and OEU with assistance from P&CSD generates Technical Package including P/P testing, make-up catalyst requirements and Pre-delivery Sample requirements as a basis for the catalyst vendor quotation. P&CSD and Law Department are to assist OEU and RTSD in developing Proforma Performance Guarantee. OEU should provide operating data to support the Major Operation Mode stated in Technical Package, i.e., operation mode in hydrocracker and FCC, and RON for naphtha reformer. The Technical Package may request performance information for Minor Operating Mode.

7.3 OEU will send Pre-development Requisition to Purchasing and P&CSD will send Technical Package and Proforma Performance Guarantee to Purchasing who requests written quotation from vendors including performance data, performance guarantees, pricing, pilot plant testing samples and secrecy agreements if required, and catalyst delivery information for evaluation. Vendors are required to complete the provided Proforma Performance Guarantee and inform Purchasing of any changes. Purchasing sends technical proposals and Proforma Performance Guarantee to OEU, RTSD, and P&CSD for evaluation. P&CSD forwards technical proposal to R&DC.

7.4 Pilot Plant Testing is not mandatory for every catalyst selection. It is one of several tools that can be used for catalyst evaluation. P&CSD and R&DC will recommend to the Refinery's management either to conduct pilot plant test of the most viable catalyst systems for performance verification or not.

Pilot Plant Test Recommended

7.4.1 P&CSD and R&DC define the scope of pilot plant testing.

7.4.2 OEU, RTSD, P&CSD, and R&DC are to set pilot plant testing expectations and P&CSD will coordinate pilot plant testing program.

7.4.3 The Refinery's Management agrees to absorb costs if pilot plant test is to be conducted outside of R&DC.

7.4.4 OEU, RTSD, P&CSD, and R&DC will evaluate pilot plant data. Meanwhile, the Technical Team will advise Purchasing when negotiating performance guarantees with vendors of the selected catalyst systems.

No Pilot Plant Test Recommended

7.4.5 Technical Team advises Purchasing in negotiating performance guarantees with vendors of the selected catalyst systems.

7.5 Purchasing and P&CSD conduct a comprehensive economic evaluation with inputs from FPD, RTSD and OEU. Product prices published by Long Range Planning Department should be used in the economic evaluation and these prices should be adjusted for product qualities, if applicable. The extent of the economic evaluation will depend on the requirements of the application. The economic evaluation might need LP model runs and inputs from Oil Supply Planning and Scheduling, and consider TLCC of the catalyst.

7.6 OEU, RTSD, P&CSD, and R&DC recommend the selected catalyst system. Purchasing will notify OEU, RTSD and P&CSD of the selected vendor. OEU will request the Law Department to review the Proforma Performance Guarantee, prepare the purchase requisition form 8920, and will prepare an executive brief if Vice Presidential approval is required. Purchasing will issue the purchase requisition through SAP with the Proforma Performance Guarantee and the executive brief, if required, attached for refinery's management approval. OEU will request Purchasing to issue the purchase order. Through this refinery's management approval process, Purchasing is authorized to sign the purchase order and the Proforma Performance Guarantee. P&CSD, RTSD, OEU, and Law Department need to agree with the guaranteed values before purchase of the catalyst. Purchasing should send a copy of the signed Proforma Performance Guarantee to OEU and P&CSD.

7.7 Purchasing will issue a purchase order to catalyst vendor allowing adequate time for delivery of catalyst system. RTSD is responsible for precious metal accounting, if catalysts contain precious metals.

7.8 The selected catalyst vendor ships Pre-delivery Sample together with the vendor's analytical results and the secrecy agreement required for conducting QA/QC to R&DC. Refining Unit of R&DC analyzes Pre-delivery Samples and

notifies OEU, RTSD, Purchasing, and P&CSD of the results. Purchasing informs catalyst vendor to ship catalyst to facility if QA/QC tests pass.

7.9 OEU contacts catalyst vendor regarding loading and startup assistance, if required.

7.10 OEU collects three kilograms of Commercial Batch Sample for each main catalyst (10%+) during the catalyst loading. This Commercial Batch Sample needs to be taken uniformly during the loading of each batch of catalyst into the reactor.

7.11 OEU and RTSD will conduct performance tests according to the refinery's management directives including those tests and timing required to validate the catalyst vendor's performance guarantee.

7.12 OEU and RTSD will retain operating data from start-up through the end of the performance guarantee period. RTSD will share operating data with P&CSD and R&DC.

7.13 Refining Unit of R&DC retains Commercial Batch Samples for five years.

8 Quality Assurance and Quality Control (QA/QC)

8.1 The Gas Processing Unit in R&DC is responsible for QA/QC testing of desiccant, and Claus catalyst; the Refining Unit in R&DC is responsible for QA/QC testing of all refining process catalysts.

8.2 All tests will be carried out in accordance with the secrecy agreement signed with the catalyst vendors. QA/QC tests for FCC catalyst typically include, but are not limited to Al_2O_3, Na_2O and Re_2O_3 contents; microactivity; apparent bulk density (ABD); particle size distribution; average particle size; unit cell size; matrix, zeolite and total surface areas; and attrition index. QA/QC tests for Claus catalyst typically include porosity, surface area, crush strength, ABD, particle size distribution, and pore size distribution. QA/QC tests for refining process catalysts, excluding FCC catalysts, typically include metal contents, ABD, crush strength, attrition, surface area, pore volume, and pore size distribution. Tests for desiccant typically include crush strength, accelerated degradation, rate of water vapor uptake, and mass transfer zone characteristics.

8.3 Other requests for testing can be initiated by P&CSD, or Operations Engineering organizations.

8.4 Gas Processing Unit or Refining Unit in R&DC will notify the proponent organizations of QA/QC testing results.

9 First-Fill Catalyst for Grass Roots or Revamp Unit

9.1 Licensor generally selects the catalyst for a grass roots or a revamp project. However, PMT or FPD shall contact P&CSD which will liaise with OEU, RTSD, and R&DC regarding the optimal catalyst system for a grass roots or a revamp project before selecting a Licensor.

9.2 The selection of the catalyst(s) shall be the joint responsibility of P&CSD, R&DC, RTSD, and the OEU of the operating facility organization.

9.3 PMT or FPD shall provide the operating organization OEU, RTSD, P&CSD, and R&DC information and allow them two weeks to make the recommendation.

9.4 If licensor offers choices for first-fill catalyst for a grass roots or a revamp project, PMT shall contact P&CSD which will liaise with OEU, RTSD, and R&DC for catalyst selection.

10 Catalyst Ex-Situ Regeneration and Disposal

10.1 Saudi Aramco refineries routinely utilize ex-situ regeneration of certain hydroprocessing catalyst in order to meet T&I schedules. P&CSD will advise ex-situ catalyst regeneration service vendors.

10.2 With vendor's consent, Refining Unit in R&DC shall analyze metal contents, ABD, crush strength, attrition, surface area, pore volume, and pore size distribution of the regenerated refining process catalyst and report results to OEU, RTSD, and P&CSD.

10.3 OEU, RTSD, P&CSD, and R&DC shall determine the need for pilot plant testing of the regenerated catalysts.

10.4 Catalyst regeneration service provider should guarantee the quality of the regenerated catalysts.

10.5 The requirement for catalyst disposal is met by shipment to the Class II Land-fill located at Abqaiq, S.A. OEU shall contact Environmental Protection Department for advice regarding Catalyst and Desiccant Material Service Group 148000 disposal.

10.6 Precious metals recovery of Platforming catalyst is accomplished through the coordinated efforts of RTSD, Material Supply, and ASC, Houston, Texas USA. RTSD will coordinate the out-of-Kingdom precious metals pool. They are responsible for tracking, recording, and accounting for pool metals as outlined in

Accounting Instruction AI-355. ASC will maintain contracts with metal reclaiming companies in the USA.

11 Procurement

11.1 Figure 1 and Section 6.2 shall be used as the protocol to follow in the procurement process for desiccants. Figure 2 and Section 7 shall be used as the protocol to follow in the procurement process for refining process catalysts. Section 6.3 shall be used as the protocol to follow in the procurement for Claus catalyst.

11.2 Contact P&CSD, and the Standardization Engineer to resolve technical issues related to Standardization. The RSA may give written approval for substitution of catalysts or desiccants with equivalent characteristics and performance. Deviations require waiver approval in accordance with SAEP-302 before issuance of a Purchase Order. For deviations identified after a Purchase Order is issued, the waiver approval is required prior to shipment.

11.3 Contact the Purchasing/Catalyst and Desiccant Material Service Group148000 Buyer to resolve problems with delivery from vendors.

11.4 Contact Gas Processing Unit/R&DC to address QA/QC problems with desiccant, and Claus catalyst. Contact Refining Unit/R&DC to address QA/QC problems with refining process catalysts.

12 Catalyst and Desiccant Material Service Group 148000 Vendors

12.1 Vendor Qualification

Saudi Aramco has an established procedure for the qualification of new vendors through the Supplier Support Division/Purchasing Department. If in doubt, contact them to determine if a catalyst or desiccant vendor has already been approved.

12.2 Restricted Vendor List

Consult the Catalyst and Desiccant Material Service Group 148000 Buyer in Purchasing for this information.

12.3 Vendor-provided Test Data

The vendor shall provide, at the request of a Saudi Aramco engineer or scientist, independent laboratory test data, internal laboratory test data, or field case histories to support his claims for the performance of any product that he may request Saudi Aramco to evaluate for its use.

13 Organization Representative

Member	Organization
Daniel Longstaff	R&DC, RU
Tom A. Owen	Purchasing Dept.
Ali Al-Nasif (alt.)	Purchasing Dept.
Zeyad S. Khoshaim	Law Department
Jamal Anabtawi	RTSD
Menahi Al-Utabi	Ras Tanura Refinery, OEU
Noamam Al-Fudhail (alt.)	Ras Tanura Refinery, OEU
Sidney Anderson	Jeddah Refinery, OEU
Abdulrehman Al-Anazi	Riyadh Refinery, OEU
Khalil Al-Saeedi	Rabigh Refinery, OEU
Fahad Al-Shetairi	Yanbu Refinery, OEU
Gene J. Yeh	P&CSD, CCU
Vaughn E. Gdula (desiccant)	P&CSD, GPU
Pierre Crevier (Claus catalyst)	P&CSD, GPU

Note: *Each representative is responsible for updating his or her organization representative information if changed. To update, please contact secretary of P&CSD/CCU at 873-0355 who will keep the recent updated list.*

Revision Summary

29 September 2004 Major revision.
30 November 2004 Editorial revision to include Figures 1 and 2.

Figure 1 – Desiccant Procurement Protocol

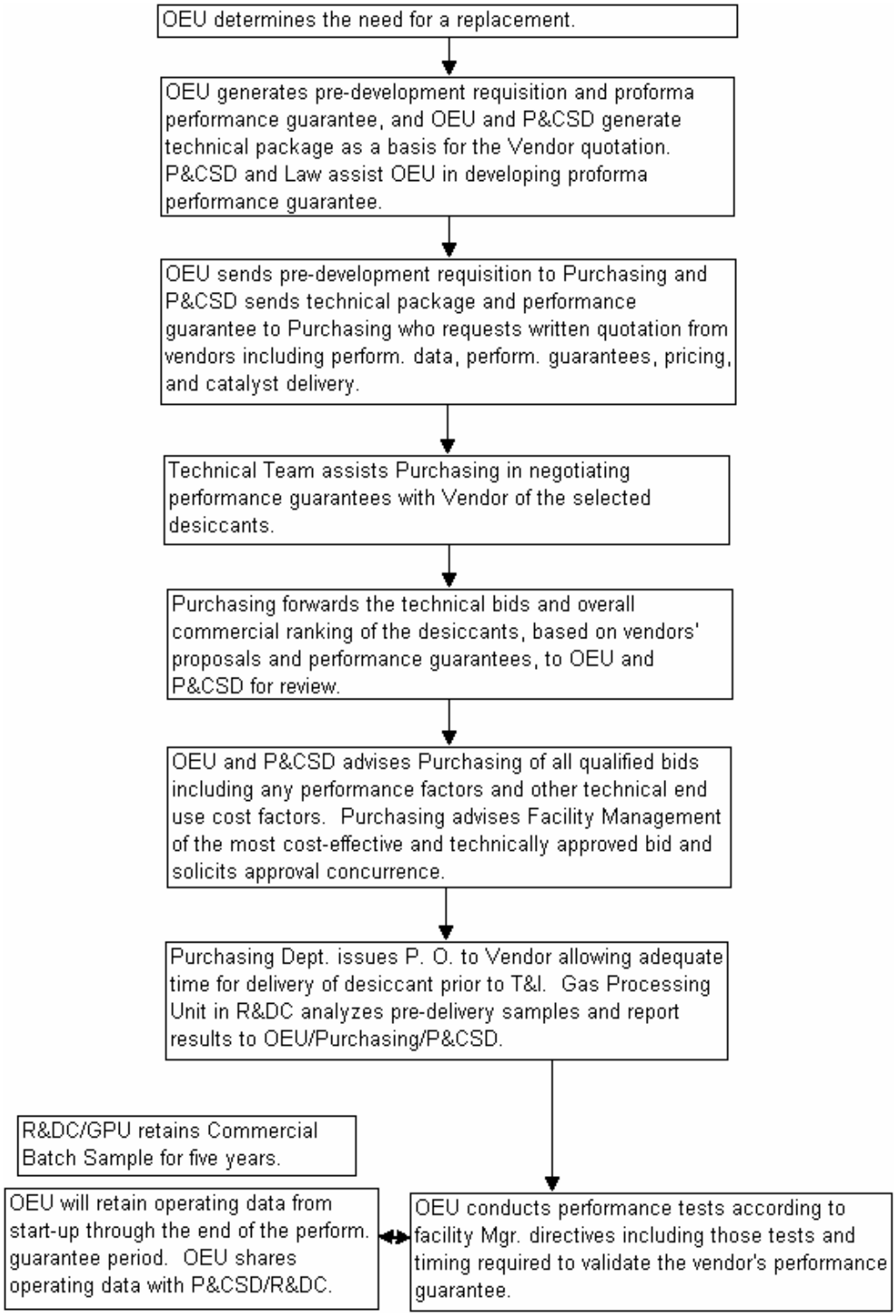

Figure 2 – Refining Process Catalyst Selection Protocol